

SPACE TRANSPORTATION PROPULSION SYSTEMS SYMPOSIUM

DEVELOPMENT, MANUFACTURING, AND CERTIFICATION PANEL

NONDESTRUCTIVE EVALUATION SUB-PANEL MEMBERS

ALEX VARY, LEWIS RESEARCH CENTER, COORDINATOR

GEORGE BAAKLINI, LEWIS RESEARCH CENTER, CONTRIBUTOR

JOSEPH HEYMAN, LANGLEY RESEARCH CENTER, CONTRIBUTOR

ERIC MADARAS, LANGLEY RESEARCH CENTER, CONTRIBUTOR

CHARLES SALKOWSKI, JOHNSON SPACE CENTER, CONTRIBUTOR

BERT WESTON, PRATT & WHITNEY AIRCRAFT, CONTRIBUTOR

KEN WOODIS, MARSHALL SPACE FLIGHT CENTER, CONTRIBUTOR

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NONDESTRUCTIVE EVALUATION (NDE) SUB-PANEL

OVERALL GOALS

- MEET THE CHALLENGES OF ADVANCED SPACE PROPULSION WITH INNOVATIVE NDE CONCEPTS**
- INCORPORATE NDE IN MATERIALS DEVELOPMENT, TESTING, AND COMPONENT DESIGN/ANALYSIS**
- ASSURE HIGHEST POSSIBLE QUALITY BY IN-PROCESS MONITORING OF MANUFACTURING STAGES**
- DEVELOP TECHNIQUES FOR VERIFICATION OF FAULT-TOLERANCE OF CRITICAL COMPONENTS**
- UTILIZE IN-SITU NDE FOR DETERMINING ON-ORBIT, IN-FLIGHT SERVICE REQUIREMENTS**

MAJOR NASA PROGRAMS REQUIRING NDE

- HIGHTEMP HIGH TEMPERATURE MATERIALS INITIATIVE
- NASP NATIONAL AEROSPACE PLANE
- HSCT HIGH SPEED CIVIL TRANSPORT
- RSRM REUSABLE SOLID ROCKET MOTORS
- ASRM ADVANCE SOLID ROCKET MOTORS
- ALS ADVANCED LAUNCH SYSTEMS
- SSME SHUTTLE MAIN ENGINE
- SSF SPACE STATION FREEDOM
- EOS EARTH OBSERVATIONAL SATELLITES
- GCTI GLOBAL CHANGE TECHNOLOGY INITIATIVE
- SEI SPACE EXPLORATION INITIATIVE

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NONDESTRUCTIVE EVALUATION (NDE) SUB-PANEL

MAIN ISSUES

- MATERIALS CHARACTERIZATION
- REDUCTION OF MANUFACTURING DEFECTS
- STANDARDS AND CERTIFICATION
- ADVANCED NDE TECHNIQUES
- DESIGNING FOR INSPECTABILITY

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MATERIALS CHARACTERIZATION - ISSUES

- NONDESTRUCTIVE ASSESSMENT AND VERIFICATION OF PHYSICAL AND MECHANICAL PROPERTIES
- NONDESTRUCTIVE ASSESSMENT OF DAMAGE ACCUMULATION AND DEGRADATION OF PROPERTIES
- INCORPORATION OF NDE INFORMATION IN CONSTITUTIVE MODELLING AND PERFORMANCE PREDICTION

MATERIALS CHARACTERIZATION - OBJECTIVES

- ESTABLISH CORRELATIONS/THEORY, CAPABILITIES AND LIMITATIONS OF NDE TECHNIQUES
- METHODS FOR EVALUATING/VERIFYING BOND QUALITY/INTEGRITY, COHESIVE/ADHESIVE STRENGTH
- DETERMINATION OF SUSCEPTIBILITY TO AND EMBRITTLEMENT BY EXPOSURE TO HYDROGEN
- ENHANCEMENT OF FRACTURE ANALYSIS AND CONSTITUTIVE MODELLING PERFORMANCE PREDICTIONS

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REDUCTION OF MANUFACTURING DEFECTS - ISSUES

- APPLY NDE METHODS TO AUGMENT MATERIALS DEVELOPMENT AND PROCESSING RESEARCH
- DEVELOP NDE METHODS FOR IMPROVING PROCESSING AND FABRICATION OF NEW MATERIALS

REDUCTION OF MANUFACTURING DEFECTS - OBJECTIVES

- EVOLVE, CALIBRATE, APPLY NDE TECHNOLOGY FOR DEFECT CHARACTERIZATION IN PROCESS CONTROL
- UTILIZE NDE INFORMATION TO DETERMINE DETRIMENTAL PROCESSING/FABRICATION PARAMETERS
- ENHANCE ACCEPTANCE AND RELIABILITY OF NEW MATERIAL SYSTEMS, E.G., ADVANCED COMPOSITES
- ENHANCE ACCEPTANCE AND RELIABILITY OF ADVANCED ALLOY PROCESSING AND JOINING METHODS

STANDARDS AND CERTIFICATION - ISSUES

- DEVELOPMENT OF CALIBRATION METHODS AND STANDARD PROCEDURES FOR NEW MATERIALS
- DEVELOPMENT OF COMPREHENSIVE DATA BASE FOR PROBABILITY-OF-DETECTION STATISTICS
- DEVELOPMENT OF PERSONNEL TRAINING AND AUTOMATED/ROBOTIC INSPECTION/ASSESSMENT METHODS

STANDARDS AND CERTIFICATION - OBJECTIVES

- CONSISTENT STANDARDS FOR NDE EQUIPMENT/METHOD CERTIFICATION AND CALIBRATION
- CORRECT INTERPRETATION, ENHANCED PRECISION, AND CORRECT PREDICTIONS FROM NDE DATA
- IMPROVED PROBABILISTIC APPROACHES IN CONCORDANCE WITH PROBABILISTIC FRACTURE ANALYSIS
- ACCOMMODATION OF UNIQUE/COMPLEX COMPONENT CONFIGURATIONS AND INTERNAL ARCHITECTURES

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ADVANCED NDE TECHNIQUES - ISSUES

- INTERMITTENT/CONTINUOUS HEALTH/DEGRADATION MONITORING OF MATERIALS/STRUCTURES
- HEALTH/DEGRADATION MONITORING IN HIGH-TEMPERATURE, HOSTILE SERVICE ENVIRONMENTS
- SPECIAL INSPECTION/MONITORING NEEDS FOR NUCLEAR PROPULSION AND ENERGY CONVERSION

ADVANCE NDE TECHNIQUES - OBJECTIVES

- CONCEPTION/DEVELOPMENT OF SMART MATERIALS/STRUCTURE WITH IMPLANTED PROBES/SENSORS
- IN-SITU MONITORING OF IMPACT RESPONSE, SERVICE DEGRADATION OF CRITICAL STRUCTURES
- REAL-TIME MONITORING OF TEST-BED AND IN-SERVICE ENGINE FIRINGS AND OPERATION
- ANTICIPATE AND REDUCE RISKS OF LEAKS, CONTAMINATION, EXPLOSION, RADIATION HAZARDS

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DESIGNING FOR INSPECTABILITY - ISSUES

- ANTICIPATION OF NDE REQUIREMENTS IN COMPONENT DESIGN FOR ENHANCED INSPECTABILITY
- DESIGN MODIFICATIONS FOR INCORPORATION OR RETROFITTING OF NDE INSTRUMENTATION
- INTEGRATION OF NDE PROBES, SENSORS, OR INDICATORS IN MATERIALS AND COMPONENTS

DESIGNING FOR INSPECTABILITY - OBJECTIVES

- ASSURE ACCESS TO CRITICAL REGIONS FOR FLAW DETECTION AND HEALTH MONITORING
- ASSURE PRECISE MATERIAL PROPERTIES VERIFICATION AND DEGRADATION/DAMAGE ASSESSMENT
- CONFIRM INTERNAL MATERIAL CONDITIONS ASSUMED IN FRACTURE AND CONSTITUTIVE MODELS

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CANDIDATE PROGRAMS/MILESTONES

- MATERIALS CHARACTERIZATION TECHNIQUES FOR HITEMP CERAMIC AND METAL MATRIX COMPOSITES
- CONSTITUTIVE MODELING, COMPONENT DESIGN, AND LIFE PREDICTION USING ADVANCED NDE METHODS
- COMPREHENSIVE CALIBRATION STANDARDS AND PROBABILITY-OF-DETECTION FOR NEW MATERIALS
- IMPLANTED SENSOR AND DESIGN-FOR-INSPECTABILITY ENHANCEMENT/RETROFITTING TECHNOLOGY
- QUANTITATIVE ASSESSMENT OF BOND STRENGTH IN ADHESIVE JOINTS, E.G., ASRM, RSRM CASES
- ASSESSMENT OF SUSCEPTIBILITY AND HYDROGEN EMBRITTLEMENT IN SSME AND SSE POWER MODULES
- WELD PROCESS CONTROL AND INSPECTION FOR CRITICAL POWER AND PROPULSION SYSTEM COMPONENTS
- INSPECTION FOR FILAMENT-WOUND AND THIN-WALL PRESSURE VESSELS, E.G., SSE, EOS, ALS, HSCT
- ADVANCED METHODS FOR DEGRADATION ASSESSMENT: CHEMICAL, THERMAL, AND MECHANICAL
- METHODS FOR MONITORING PROPULSION AND AERODYNAMIC COMPONENTS AT EXTREME TEMPERATURES

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CANDIDATE PROGRAMS/MILESTONES

○ PROGRAMS/MILESTONES UNIQUE TO SOLID PROPULSION

- PROPELLANT AGING INSPECTION, PROPELLANT DEFECTS, IGNITER INTEGRITY
- CASE-LINER-PROPELLANT BONDLINE INTEGRITY, ADHESIVE STRENGTH MEASUREMENTS
- ADVANCED COMPOSITE STRUCTURAL MATERIALS INSPECTION
- REAL-TIME INSULATION CHARACTERIZATION AND EROSION MONITORING
- CASE IMPACT DAMAGE ASSESSMENT, METAL/COMPOSITE CASE INTEGRITY/DAMAGE
- RESIDUAL STRESS MEASUREMENTS: IN METALLIC/COMPOSITE STRUCTURES, BONDLINE
- SPECIFIC METHODS FOR CRITICAL FASTENERS, O-RINGS, NOZZLES, EXIT CONES

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CANDIDATE PROGRAMS/MILESTONES

○ PROGRAMS/MILESTONES UNIQUE TO LIQUID PROPULSION

- INJECTOR/MANIFOLD ASSEMBLY, COOLING PASSAGE, TURBOMACHINERY INTEGRITY
- THERMAL PROTECTION SYSTEM BOND INTEGRITY
- STRESS CORROSION CRACKING, LEAK CHECKING, AND HYDROGEN EMBRITTLEMENT
- TANKAGE, WELDS, AND BRAZED JOINTS FLAWS/INTEGRITY (THIN WALLED STRUCTURES)
- RESIDUAL MOISTURE IN ENGINE COMPONENTS, VALVE CONTAMINATION
- COATED SUBSTRATES: CERAMIC COATED TURBINE BLADES, COPPER/GOLD PLATINGS
- DATABASE ON CORRELATION BETWEEN ACTUAL AND PREDICTED WELD DEFECTS/CRITICALITY

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CANDIDATE PROGRAMS/MILESTONES

○ GENERAL PROGRAMS/MILESTONES FOR SPACE SYSTEMS

- DEFINITION OF SPECIFIC/UNIQUE ON-ORBIT, IN-SPACE, EXTRATERRESTRIAL NDE NEEDS**
- DELINEATION BETWEEN ON-ORBIT AND SAMPLE RETURN FOR TERRESTRIAL INSPECTIONS**
- ON-ORBIT, IN-SPACE HEALTH MONITORING OF ENGINE/MOTOR/PROPULSION COMPONENTS**
- ON-ORBIT NDE TOOL KITS, ROBOTIC/AUTOMATED NDE, ASTRONAUT NDE SPECIALISTS**
- APPLICATIONS OF SMART MATERIALS, IMPLANTED SENSORS, AUTONOMOUS EXPERT SYSTEMS**
- DATABASE FOR NDE POD STATISTICS, STANDARDS/METHODS FOR 90/95 DETECTION**
- CALIBRATION STANDARDS, INSPECTOR/SUPPLIER CERTIFICATION, EDUCATION/TRAINING**
- INSITU MONITORING/FEEDBACK DURING PROCESSING, FABRICATION, FLIGHT OPERATION**

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NDE TECHNOLOGY POTENTIALS

- ULTRASONIC METHODS FOR CHARACTERIZING MICROSTRUCTURE AND MECHANICAL STRENGTH/MODULI**
- COMPUTED TOMOGRAPHY FOR INTERNAL ARCHITECTURE AND INPUT TO PERFORMANCE/LIFE ANALYSIS**
- PIEZO-FIBER, FIBER-OPTICS, ELECTRO-FILMS FOR SMART MATERIALS AND INSITU EVALUATIONS**
- ULTRASONIC AND MULTIPARAMETER NEURAL NETWORKS FOR EVALUATING BONDED JOINT STRENGTH**
- ELECTROMAGNETIC AND ULTRASONIC METHODS FOR HYDROGEN AND ENVIRONMENTAL EMBRITTLEMENT**
- MICROFOCUS RADIOGRAPHY, ACOUSTIC MICROSCOPY, HOLOINTERFEROMETRY FOR WELD INSPECTION**
- SCANNING LASER SPECTROSCOPY, THERMOMICROSCOPY FOR SURFACE CONTAMINATION/DEGRADATION**
- ACOUSTIC EMISSION AND LASER ULTRASONICS FOR MONITORING HEALTH OF PROPULSION SYSTEMS**
- MULTIPARAMETER ANALYTICAL NDE METHODS FOR PROCESS CONTROL AND MATERIALS CERTIFICATION**